



Traditional

A story of Impact

NIOSH Light-Emitting Diode (LED) Cap Lamp Improves Illumination and Decreases Injury Risk for Underground Miners

Working in an underground mine presents many unique challenges. One significant challenge is providing adequate lighting for miners to work safely. The Illuminating Engineering Society of North America (IESNA) identifies an underground coal mine as the most difficult environment in the world to illuminate,¹ yet miners depend most heavily on vision to identify and avoid hazards as they navigate their work environment.² Many of the higher frequency risks in mining are related to the challenge of inadequate lighting. This includes slip, trip, and fall (STF) hazards which can be more difficult to detect in low light: in 2007 there were 254 STF injuries among underground miners.³ Inadequate light can also prevent a miner from seeing an approaching machinery hazard; 31 miners were fatally pinned or crushed by machinery between 1983-2009.⁴

With increased age can come decreased visual abilities, particularly in low light environments. The average age of the mining workforce is 45 years;⁵ as the mining workforce ages, the need for effective underground lighting becomes even more pressing.

▲ A visibility comparison between the NIOSH LED Cap Lamp and a traditional cap lamp product. Photo by Justin Srednicki.

Relevant Information

The rate of fatal injuries in the coal mining industry in 2006 was nearly 12 times that in all other private industries.⁸

80% of perception is visual, making illumination essential for avoiding hazards in all settings.⁹

The noisy mining environment can mask audible signs of approaching hazards, making visual cues even more critical.¹⁰



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Traditional mine lighting consists of a low level of background light, along with a high-intensity, yellow-tinted incandescent spot light from a miner's cap lamp or piece of machinery. This traditional method, with a narrow beam of bright light fixed in a single location, is not very adaptable to the variety of lighting needs that a miner may encounter. There is also a risk of decreased visibility from the glare of this spotlight. One study found 78% of test subjects complaining of glare from traditional lighting systems.⁶

Impact

Researchers at the National Institute for Occupational Safety and Health (NIOSH) set out to discover whether alternative lighting methods could provide more effective lighting and improve safety in the mining environment. Initial research explored the effectiveness of a NIOSH-developed light-emitting diode (LED) cap lamp when compared to both a traditional incandescent and a commercially-available LED cap lamp; the NIOSH product reduced disability glare—crucial for seeing any hazard—by up to 54%.⁶ The latest NIOSH-developed LED cap lamp is more flexible than other cap lamps, with the capacity to better illuminate mine hazards and to adjust lighting distribution and intensity. When compared to other commercially-available LED cap lamps, this newest design improved floor hazard detection up to 194%, and improved peripheral motion detection—crucial for detecting moving machinery hazards—up to 79%.⁷ These impressive results have led to 5 changes in the international standard for cap lamps used in mines that will be published by the International Electrotechnical Commission in early 2012, impacting the manufacturing of all future cap lamps. In addition, one cap lamp manufacturer has used the research results to update their testing and product, including changes in light beam distribution and LED color temperature. It is likely that additional cap lamp manufacturers will make similar modifications in order to remain competitive in the marketplace. These changes to cap lamp manufacturing and standards have the capacity to dramatically improve mine illumination worldwide and decrease the risk of injury and death among underground miners.

For more information on mining cap lamps go to www.cdc.gov/niosh/mining, or for other occupational safety and health information visit the NIOSH Web site at www.cdc.gov/niosh. Authors of NIOSH Light-Emitting Diode (LED) Cap Lamp—John Sammarco, Timothy Matty, and Grant King; Office of Mine Safety and Health Research; NIOSH—received the 2011 Bullard-Sherwood r2p Award in the Technology category. Miguel Reyes, Timothy Lutz, Justin Srednicki, Alan Mayton, Sean Gallagher, Mary Ellen Nelson, and Albert Cook conducted human subject testing.

¹⁻¹⁰ For a complete list of references, see www.cdc.gov/niosh/docs/2011-192/.

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